UCRL-50027-97

Environmental Report 1997

Executive Summary

California Red-Legged Frog
Rana aurora draytonii

Lawrence Livermore National Laboratory

Cover

The California red-legged frog (*Rana aurora draytonii*), a federally threatened species, established new populations at both the LLNL Livermore site and Site 300 in 1997. The California red-legged frog is the largest native frog in California, growing up to 138 mm, or more than 5 inches long. The original Calaveras jumping frog, it uses its strong legs to move long distances to find water during drought periods. At both LLNL sites its habitat is protected by use of project exclusion zones to protect breeding areas and by emplacement of shelter boxes. The editors thank wildlife photographers Liittschwager and Middleton for the use of their photograph.

Cover photograph: ©David Liittschwager & Susan Middleton 1996

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Introduction

Lawrence Livermore National Laboratory (LLNL), a U.S. Department of Energy (DOE) facility operated by the University of California, serves as a national resource of scientific, technical, and engineering capabilities. The Laboratory's mission focuses on nuclear weapons and national security, and over the years has been broadened to include areas such as strategic defense, energy, the environment, biomedicine, technology transfer, the economy, and education. The Laboratory carries out this mission in compliance with local, state, and federal environmental regulatory requirements. It does so with the support of the Environmental Protection Department, which is responsible for environmental monitoring and analysis, hazardous waste management, environmental restoration, and assisting Laboratory organizations in ensuring compliance with environmental laws and regulations.

LLNL comprises two sites: the Livermore site and Site 300. The Livermore site occupies an area of 3.28 square kilometers on the eastern edge of Livermore, California. Site 300, LLNL's experimental testing site, is located 24 kilometers to the east in the Altamont Hills, and occupies an area of 30.3 square kilometers. Environmental monitoring activities are conducted at both sites as well as in surrounding areas.

This summary provides an overview of LLNL's environmental activities in 1997, including radiological and nonradiological surveillance, effluent, and compliance monitoring, remediation, assessment of radiological releases and doses, and determination of the impact of LLNL operations on the environment and public health.

Environmental Monitoring Results

During 1997, the Environmental Protection Department sampled air, sewerable water, ground water, surface water, soil and sediment, vegetation and foodstuff, and measured environmental radiation. Over 24,000 environmental samples were taken and results were obtained for more than 260,000 analytes.

LLNL's sampling networks undergo constant evaluation. Changes are made, as necessary, to ensure adequate and cost effective monitoring of all environmental media potentially affected by LLNL operations. Once samples are collected, they are analyzed for radioactive and nonradioactive substances using standard methods such as

analytical procedures approved by the U.S. Environmental Protection Agency (EPA), special systems such as the continuous monitoring system for Livermore site sewage, or special analytical techniques designed to measure very low levels of radionuclides. Environmental radiation is also measured directly using dosimeters.

Air Monitoring

Air surveillance monitoring was performed for various airborne radionuclides (including particles and tritiated water vapor) and beryllium at locations on the Livermore site and Site 300, and at off-site locations throughout the Livermore Valley and Tracy area. Concentrations of all monitored radionuclides and beryllium at all of these locations were well below levels that would endanger the environment or public health, according to current regulatory standards. As examples: in 1997, the concentration of plutonium on air filter samples collected at LLNL on-site locations, perimeter locations, and Livermore Valley locations showed median values, respectively, of only 0.0064%, 0.0012%, and 0.0014% of the federal Derived Concentration Guide (DCG). The DCG specifies the concentration of radionuclides in air or water that could be inhaled or ingested continuously 365 days a year without exceeding the DOE radiation protection standard for the public. Median concentrations of tritiated water vapor at Livermore Valley sampling locations showed a highest median value of 0.002% of the DCG, while the highest median values on the Livermore site perimeter and within the site boundaries were, respectively, 0.007% and 0.1% of the DCG. The highest median concentration of beryllium on the Livermore site perimeter was 0.1% of the guideline level established by the Bay Area Air Quality Management District and the EPA. Similar results (small fractions of guideline levels) were found at air surveillance monitoring locations at Site 300 and its environs.

Effluent Monitoring

At the start of 1997, stack air effluent was monitored continuously for radionuclides at nine buildings on the Livermore site; by the end of the year this number was reduced to six buildings as operations changed. Presently monitored facilities are the Tritium Facility (Building 331), the Plutonium Facility (Building 332), the Heavy Element Facility (Building 251), and three buildings involved with Laser Isotope Separation program activities. Building 331 emissions accounted for 97% of the estimated total tritium emissions from the site in 1997; emissions from this facility remain at a level far below those of the 1980s. Radionuclide emissions from the other monitored facilities were very low. This data from stack effluent monitoring gives an accurate, time resolved measure of the quantity of radionuclides released from these major facilities, and provides realistic source terms to improve the quality and credibility of our air dispersion and dose assessment modeling.

Nonradioactive air emissions from exempt and permitted sources at LLNL were quite small and typical of values in previous years. For example, total emission of nitrogen oxides from the Livermore site in 1997 was about 59 kg / day, which is 0.012% of the quantity of this air pollutant released daily over the entire Bay Area; corresponding numbers for reactive organics are 37 kg / day and 0.007%. The total emission of criteria air pollutants (nitrogen oxides, sulfur oxides, particulate matter, carbon dioxide, and lead) is approximately 100 kg / day for the Livermore site and about 25 times smaller for Site 300.

Wastewater Monitoring

Discharges of radioactive and hazardous materials to the combined sanitary and industrial sewer at the Livermore site are controlled by limiting the disposal of those materials, implementing engineering controls, and routing some discharged material to retention tanks for later characterization and treatment. Flow-proportional samples of discharged wastewater are regularly collected and analyzed (for metals, radioactivity, toxic chemicals, and water-quality parameters) to assure that LLNL's sewage effluent meets the requirements of the permit granted by the City of Livermore. In addition, effluent is monitored continuously for pH, selected metals, and radioactivity. Should concentrations be detected above warning levels, an alarm sounds and LLNL's sewer diversion system is automatically activated. The diversion system captures all but the first few minutes of wastewater flow that causes an alarm, thereby protecting the Livermore Water Reclamation Plant (LWRP) and minimizing any required cleanup.

In 1997, the Livermore site discharged an average of 0.91 million liters per day of wastewater to the City of Livermore sewer system, an amount that constitutes 4.4% of the total flow to the system (about 20% of this flow was generated by Sandia National Laboratories / California). The Livermore site's sanitary sewer discharges are sampled continuously, daily, weekly, and monthly to satisfy various permit compliance requirements.

LLNL achieved greater than 99% compliance with LWRP permit limits covering discharges into the sanitary sewer during 1997. However, five notices of violation (NOVs) were written for violations that occurred. It should be emphasized that LLNL's sewer diversion system is designed to prevent large releases, not to preclude NOVs resulting from small releases to the sewer. One was for silver and pH exceedances, a second for a mercury exceedance, a third for a pH exceedance, a fourth for two lead exceedances, and a fifth for four different pH exceedances. Thirteen inadvertent discharges were detected by the continuous monitoring system in 1997, all involving either a metal, acid, or base, and more than half of these instances warranted sewage diversion. During 1997, no sewer releases exceeded discharge limits for radioactive materials.

Water Monitoring

Surface water sampling and analysis are a large part of the LLNL surveillance and compliance monitoring effort for the Livermore site, Site 300, and their surrounding regions. The waters monitored include storm water runoff; rainfall; reservoirs and ponds, the Livermore site's swimming pool and Drainage Retention Basin; tap water; treated ground water discharges; and wastewater discharges from cooling towers at Site 300. Depending on location, the samples may be analyzed for gross alpha and gross beta radiation, radionuclides such as tritium and uranium, and nonradioactive pollutants, including solvents, metals, explosives, pesticides, and a wide range of organic compounds; monitored properties include total suspended and total dissolved solids, conductivity, and pH. In addition, fish bioassays are performed annually.

Ground water in the Livermore Valley and the Altamont Hills is monitored to assess the progress of remediation efforts in areas of known contamination, to test that LLNL operations do not significantly impact local water sources, and to comply with numerous federal, state, and local permits. Ground water samples are routinely measured for tritium, uranium, and other radioisotopes; gross radioactivity; toxic metals; a wide range of organic chemicals; and other general contaminant indicators. Special consideration is given to monitoring those dissolved elements and organic compounds that are known to be toxic in trace amounts.

Expressed as a percentage of the regulatory maximum contaminant level (MCL) for tritium in drinking water, the 1997 maximum tritium activities measured in Livermore site and Livermore Valley surface and drinking water were at a level of 2%; the highest tritium activity measured in rainfall was 9%; and the maximum tritium activity in storm water runoff was 3%, save for one exceptional sample where the result was 49% of the MCL. Maximum gross alpha and gross beta activities in storm water were 28% and 33%, respectively, of the MCLs for these radiations. Fish toxicity tests conducted in 1997 indicated that LLNL storm water runoff has no adverse impact on off-site biota; the 96-hour survival rate for fish in undiluted storm water collected at the Livermore site perimeter was 100%.

The impact of Livermore site and Site 300 operations on off-site ground waters is minimal. At the Livermore site, no monitored radioactive or inorganic nonradioactive constituent in any off-site well was found to exceed primary drinking water MCLs. In on-site wells instances of chromium and nitrates above the primary MCL were found, but have not migrated off site. At Site 300, tritiated water and depleted uranium have been released to ground water from landfills and firing tables, but the boundaries of the slowly-moving ground water plumes lie entirely within site boundaries. The shallow ground water beneath Site 300 contains volatile organic compounds (VOCs), tritium, nitrates, Freon, and depleted uranium, but presents no current health risks, because this

contaminated water is not used as a potable domestic, livestock, or industrial water supply. Except for VOCs being remediated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at both sites, there is little or no evidence of adverse impacts on ground waters beyond the sites. In particular, the VOC plumes that were advancing to the west and southwest of the Livermore site are being pulled back to the site and treated.

Soil and Sediment Monitoring

Soil and sediment sample analyses for the Livermore site in 1997 indicated that the impact of Laboratory operations on these media were insignificant and unchanged from previous years. The highest measured level of plutonium (isotopes 239 and 240) represented 2.2% of the EPA preliminary remediation goal for commercial or industrial sites; this occurred at the Livermore Water Reclamation Plant (LWRP). Most constituents of concern were measured at background or trace concentrations, or were below the limit of detection. At Site 300, the concentrations of radionuclides and beryllium in soil samples were representative of background or naturally occurring levels, as in previous years, with the exception of two sampling locations. Elevated concentrations of uranium-238 found at locations 812N and 851N in 1997 were attributed to contamination by debris from firing table experiments.

As noted below in the section on "Safety Evaluation and Health Assessment," the federal Agency for Toxic Substances and Disease Registry (ATSDR), working with the California Department of Health Services (DHS), conducted site team meetings in 1997 on the issue of plutonium in Big Trees Park, Livermore. While stating that levels of plutonium were not a health concern, it was concluded that questions of how the plutonium got into the park and the extent of the contamination warranted further investigation. A plan to do further soil sampling is currently being devised.

Vegetation and Foodstuff Monitoring

Area vegetation and foodstuff are monitored for their tritium content. Tritium concentrations in samples taken near the Livermore site were found to be higher than those in samples taken from more distant locations, consistent with the trend of data over the last 16 years. The tritium concentrations in vegetation in 1997 were quite low and not significantly different than those reported the previous year. Potential ingestion doses estimated from the measured concentrations are well below levels of concern, even when organically bound tritium is taken into account. In 1997, as in the past, tritium concentrations in Livermore Valley wines were slightly above those for wines tested from Europe and other locations in California; but the tritium levels are quite low. Mean levels for the 1997 sampling year, using data from all areas, were not significantly different from those reported for the past several sampling years. Even the highest detected value, 8.0 becquerels per liter (215 picocuries per liter), represents only 1.1% of

the amount of tritium California allows in drinking water (no health standards exist for radionuclides in wine).

Radiological Dose Assessment

Radiological dose-assessment modeling, using EPA-mandated computer models, actual LLNL meteorology, population distributions appropriate to the two sites, and 1997 radionuclide inventory and monitoring data, was conducted this past year for all facilities and all potential emission points at the Livermore site and Site 300.

The public doses we report result from air releases of radionuclides during routine operations and (when applicable) from accidents. The principal exposure pathways are taken into account: internal exposures from inhalation of air and ingestion of foodstuff and drinking water, and external exposures from contaminated ground and immersion in contaminated air. Releases of radioactivity from LLNL via the water pathway do not directly contribute to the public dose, since they are not consumed by any individual.

The calculated total potential dose for the sitewide maximally exposed individual (SW-MEI), i.e., a hypothetical member of the public having the greatest possible exposure from Livermore site operations in 1997, was 0.97 microsievert (0.097 millirem), nearly the same as last year's value. Eighty percent of this amount was attributed to the Tritium facility, resulting mainly from decontamination and decommissioning activities. Trends in this SW-MEI dose for the Livermore site over the last six years show levels in the range 1.0 to 0.4 microsievert / y (0.1 to 0.04 millirem / y), down from 2.40 microsievert / y (0.24 millirem / y) in 1990. These are small radiation quantities, exhibiting large percentage, but small absolute value, fluctuations from one year to the next.

The calculated total potential dose to a hypothetical public individual having the greatest possible exposure at Site 300 during 1997 was 0.20 microsievert (0.020 millirem), which is the lowest level since these estimates of public dose from Site 300 operations were first made eight years ago. Explosive tests at the Building 801 firing table accounted for about 55% of this potential dose, while resuspension of depleted uranium in soils at the site (deposited by explosives experiments in previous years) accounted for 45%. This total dose is about 61% of the previous year's value, reflecting decreased activity at the firing tables in 1997. Trends in annual dose levels from Site 300 operations show that year-to-year fluctuations by about a factor of two are typical.

In determining the total dose to the public from LLNL activities, unplanned or accidental releases must be included in the assessment, as well as releases from routine operations. There was one unplanned release of radioactivity from the Livermore site in 1997. A small quantity of curium-244 escaped from Building 513 during a waste shredding operation. Analyses based on monitoring data gathered during and subsequent to the primary release event concluded that the SW-MEI dose from this accidental release was 0.0021 microsievert (0.00021 millirem). LLNL received a Preliminary Notice of Violation from DOE Headquarters for this accident and submitted an action plan designed to prevent any similar reoccurrence.

The most significant radiological effluent for the Livermore site continues to be tritium, the radioactive isotope of hydrogen. For Site 300, depleted uranium (containing isotopes with atomic weights 238, 235, and 234 in the weight percentages 99.8, 0.2, and 0.0005, respectively) is the dominant contributor to off-site dose.

Radiological doses to the maximally exposed public individuals from Livermore site and Site 300 emissions amounted to about 0.97% and 0.20%, respectively, of the EPA National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulatory standard. These doses are a small fraction (about 1/3000) of the doses received by these populations from natural background radiation. Thus, the potential radiological doses from LLNL operations in 1997 were well within regulatory limits and were very small compared to doses from natural background radiation sources.

Environmental Compliance and Program Activities

LLNL works to ensure that its operations comply with all environmental laws and federal, state, and local regulatory guidelines. Many activities related to water, air, waste, waste reduction, community "right to know," and other environmental issues were addressed in 1997.

Safety Evaluation and Public Health Assessment

LLNL's system of safety management was intensively evaluated by DOE's Office of Oversight in 1997. A 25-person evaluation team spent six weeks in this review that examined DOE/OAK and the University of California, as well. Livermore site facilities reviewed included the Plutonium Facility, Hazardous Waste Management Facility, and the National Ignition Facility, and topical areas such as radiation protection and chemical and high-explosive safety were considered. Conclusions of the evaluation were generally positive; some areas needing improvement were identified and are being acted upon.

The federal Agency for Toxic Substances and Disease Registry (ATSDR) conducted site team meetings in 1997 and contracted with the California Department of Health Services to draft two health consultations related to Livermore site operations. The first concerned levels of plutonium in Big Trees Park, Livermore (mentioned earlier in this summary in the Soil and Sediment Monitoring section); the second assessed potential impacts of Livermore site operations on the municipal water supply. LLNL is working with ATSDR to resolve comments on the health consultations and identify and execute appropriate follow-up activities.

Ground Water Remediation

Both the Livermore site and Site 300 are Superfund sites undergoing remedial activities under the jurisdiction of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). LLNL's primary treatment technology to remediate contaminated ground water is pump-and-treat technology. In 1997, seven treatment facilities at the Livermore site processed over 870 million liters of ground water, removing nearly 110 kilograms of volatile organic compounds (VOCs) plus smaller quantities of dissolved fuel hydrocarbons (FHCs). These efforts at control and remediation have stopped the off-site westward migration of VOC plumes from the Livermore site and have reduced plume size. In 1997, LLNL increased its use of portable treatment units; these provide a relatively inexpensive alternative to the fixed treatment units that have been used since 1989. Significant progress also occurred at Site 300, where more than 6 kilograms of VOCs were removed from soil and ground water in four treatment areas. Since initiating cleanup, the concentrations of Trichloroethene in the Central General Services Area of Site 300, for example, have been reduced from 9400 parts per billion (ppb) in 1993 to 380 ppb in 1997.

Waste Minimization and Pollution Prevention

A hierarchical approach to waste reduction, consisting of source elimination or reduction, material substitution, reuse and recycling, and treatment and disposal, has been adopted by LLNL, in accordance with EPA guidelines and DOE policy, and applied to all types of waste.

LLNL now employs a weighted ranking system to prioritize and evaluate its waste streams. Cost, type of waste, and operational aspects are emphasized, rather than simply considering total waste volume. The 20 waste stream components having highest priority under this system contrast sharply with the corresponding set under a waste volume ranking; transuranic and transuranic-mixed and low-level wastes now rank as highest priority for LLNL, even though their quantities are rather low.

The trend in routine waste generation at LLNL over the past eight years shows dramatic reductions in all four categories: radioactive, mixed, hazardous, and sanitary. Comparing 1997 to 1990 levels, these categories have undergone reductions of 85%, 90%, 87%, and 28%, respectively. The total waste diverted from landfills in 1997 was more than 40,000 tons, almost 10 times the total for two years earlier and twice the previous year's amount; beneficial reuse of soil on site was responsible for most of this increase. LLNL's recycling percentage for nonhazardous waste was 92% in 1997, far in excess of the DOE-stated goal of achieving 33% by the end of 1999. In fiscal year 1997, the Laboratory received a National DOE P2 (pollution prevention) award for its achievements in solid waste recycling of construction and demolition debris.

The Laboratory continued to search for and capitalize on opportunities to eliminate, reduce, recover, or recycle potential pollutants to all media, including air, water, soil, sediments, and biota. As one example, replacement and recycling of ozone-depleting Freon 113 (used in parts cleaning operations and as a coolant or refrigerant) is a high priority; by the end of 1997, Freon 113 had been replaced in all but one parts-cleaning operation.

Chemical inventories at LLNL are tracked through the use of bar codes, hand-held bar code laser scanners, and customized software in a computerized chemical inventory system called ChemTrack. The 1997 inventory featured 175,000 chemical containers ranging from 210-liter drums to gram-quantity vials. ChemTrack minimizes the purchase of new chemicals, thereby reducing procurement costs and the generation of hazardous waste, and enhances LLNL's ability to provide federally required toxic release information.

Air, Wastewater, and Water Compliance

LLNL continued to perform all activities necessary to comply with clean air and clean water requirements. In 1997, the Bay Area Air Quality Management District (BAAQMD) issued or renewed 140 permits to operate for the Livermore site. The San Joaquin Valley Unified Air Pollution Control District issued or renewed 43 permits for Site 300 operations. LLNL has permits for underground and aboveground storage tanks and for discharge of treated ground water, industrial and sanitary sewage, and storm water. Site 300 has additional permits for inactive landfills, cooling tower discharges, operation of the sewer lagoon, septic tanks, and leach fields. The Laboratory complies with all requirements for self-monitoring and inspections associated with these permits.

Environmental Occurrences

Notification of environmental occurrences at the Laboratory is required under a number of environmental laws, regulations, and DOE orders. LLNL responded to 12 incidents that required federal and/or state agency notification during 1997. None of these caused adverse impact to human health or the environment.

Endangered Species and Paleontological Resources

Two of the three known natural populations in the world of the large-flowered fiddleneck (*Amsinckia grandiflora*), a federally listed endangered plant species, occur at Site 300, which has been designated a critical habitat for the plant. In 1997, the number of fiddleneck plants in two native populations at the site drastically declined, likely because of heavy rain runoff and increased exotic grass cover. The experimental population of this plant was not diminished. Two additional sensitive plant species were identified at Site 300 in 1997: the big tarplant (*Blepharazonia plumosa*) and the diamond-petaled poppy (*Eschscholzia rhombipetala*). Regarding animals, biological assessment surveys on the Livermore site and Site 300 were performed for special status species at 83 project construction areas in 1997. Two new populations of the federally threatened red-legged frog (*Rana aurora draytonii*) were found across Site 300 in wetlands and seasonal pools and identified in the Arroyo Los Positas on the Livermore site. White-tailed kites (*Elanus lecurus*), state-protected raptors, successfully nested at the Livermore site and fledged young.

During soil excavation for the National Ignition Facility at the Livermore site, bones from a 14,000-year-old mammoth were found at a depth of about 30 ft and greater. These will be cataloged into the University of California Berkeley Museum of Paleontology collection.

Conclusion

The current techniques used at LLNL for environmental monitoring are very sensitive, allowing detection at extremely low levels of constituents. The combination of surveillance and effluent monitoring, source characterization, and computer modeling show that radiological doses to the public caused by LLNL operations are less than 1.0% of regulatory standards and are about 3000 times smaller than the doses received from background radiation. The analytical results and evaluations generally show continuing low contaminant levels, reflecting both decreased operations and the responsiveness of the Laboratory in controlling pollutants.

In 1997, significant achievements were made in environmental compliance activities related to water, air, waste, and waste reduction. Ground water remediation activities have stopped the westward migration of plumes at the Livermore site; waste minimization efforts have significantly reduced the amount of waste generated in LLNL operations; recycling efforts have diminished the quantity of waste sent to landfills; and efforts at waste reduction and pollution prevention have capitalized on a variety of opportunities to reduce or eliminate, recover, or recycle potential pollutants.

In summary, the results of the 1997 environmental programs demonstrate that LLNL is committed to protecting the environment and ensuring that its operations are conducted in accordance with applicable federal, state, and local laws and regulations. The environmental impacts of LLNL operations are minimal and pose no threat to the public or the environment.